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Harvesting of Energy from Vibration by Using Micro-Electro Mechanical Sysem

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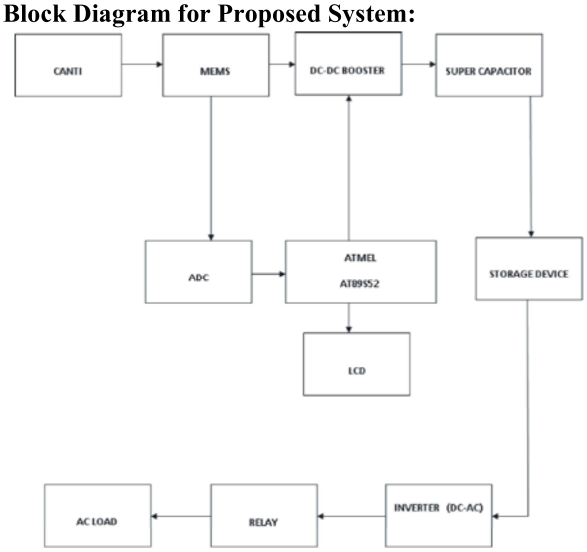
Abstract: This paper describes an analysis and a performance limit of a vibrational energy harvester.It has a separable electrate & micro-electro mechanical system(MEMS).In the MEMS part, movable electrode slide due to external vibration & receive electrical field.MEMS was choosen because of abundant vibration accessibility & energy harvesting productivity. The structure was fabricated based on MEMS technology & produced an a.c current of 170 PA with external vibration at a frequency of 1166 hz. MEMS provide an interface that can sense the process & control the surroundings.

Key words: Effectiveness · Electrets · Energy harvester · Performance limit · Vibration

INTRODUCTION

Energy harvesting means scavenging energy from vibration & is defined as conversion of ambient energy into electrical energy form. Here we are going to discuss about green energy. Green energy is the energy that produced in a manner that has less of negative impact to environment. It is renewable source of energy because it is not depleted easily & it is naturally replenished. Energy harvesting is a promising technology to realize a ubiquitous society based on wireless sensor networks. The networks consist of a lot of small sensor terminals. The sensor terminals have sensors, analog-to-digital converters and wireless transmitters and are embedded in the surroundings. An application-specific harvester's structure was designed for tire pressure monitoring systems. When electrets are used in these energy harvesters, line-patterned electrets are necessary from a vibration-to-electric conversion principle. These facts in small-sized energy harvesters make it difficult to design a closely coupled electromechanical structure that implements an energy-conversion principle. Although small-sized energy harvesters were designed and fabricated based on MEMS technology by a few groups quanti-tative assessments of output power in relation to electrets are still difficult. The object of this paper is to analyze the mechanism, clarify the dominant factors for power output and estimate maximum output, that is, harvester effectiveness. This will give a perspective of the potential of the MEMS-based energy harvesters [1].

Block Diagram for Proposed System:



In this project, we are using cantilever beam act as source of vibration for power generation. MEMS sensor placed on the beam[5], it will convert the mechanical energy generated from the movement of the beam into electrical energy. The output of MEMS is given to the ADC for analog to digital conversion and then to microcontroller in order to monitor the value of energy

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generated. The output of MEMS is also given to boost controller. The obtained energy is boosted up using Boost Controller and given to DC-DC converter. The output of the DC-DC converter is stored in a storage device. The stored energy is inverted to AC voltage and is given to the relay and utilized for other purposes for lighting lamps for example. The voltage control is provided by the microcontroller [2].

Principle: We have selected an electrostatic vibrational type of energy harvester because of easiness of process integration. The princi-ple is explained in Fig. 2. An electret has fixed charges within its dielectrics. Metal fixed and movable electrodes face the electret. The fixed charges induce counter charges into the electrodes coming from the ground. The charges are deployed to minimize the electrical-field energy between the electrodes and electret. When external force moves the movable electrodes [3-6], charges in the electrodes rearrange to minimize the electrical-field energy. During this rearrangement, charges flow between movable and fixed electrodes. This is a generated current and work is done through an external load. Thus, external vibration produces an ac current.

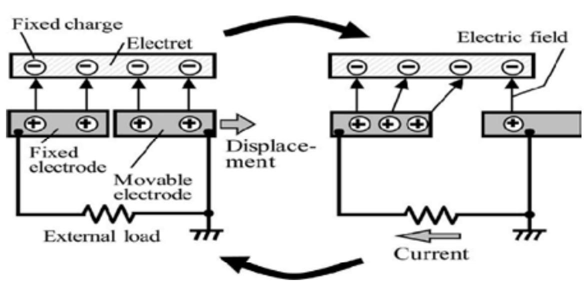
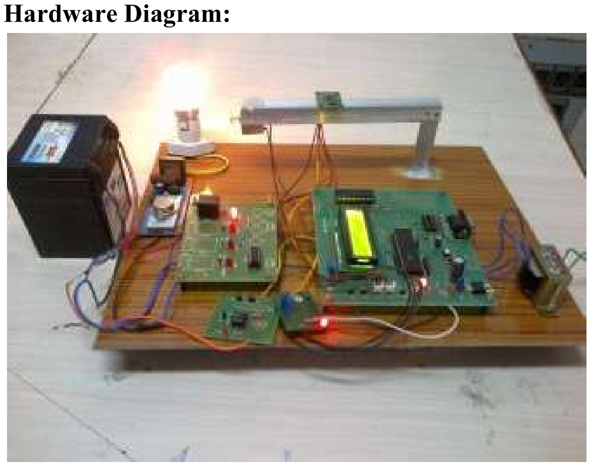


Fig.. Conversion principle of vibration to an ac current with an electret.

Hardware Diagram:



Embedded Output: With the help of the MEMS sensor, we are getting 3v power.After that, by using dc-dc booster, the obtained energy is boosted up to 12v supply.

Experimental Result

Electret: We used an ethylene–tetrafluoroethylene copolymer film as an electret. A 100-ìm-thick film was corona discharged by applying -10-kV bias voltage at room temperature. One of the surfaces of the electret film charged negatively around -450 V, while the other side charged positively around +350 V.

Current Generation: We first checked whether the fabricated device vibrated and found their resonant frequency around 1160 Hz in the vibration detection mode with bias voltage and without an electret. Next, we measured current generation as a reference without bias voltage and without an electret in the current detection mode. The value of impedance *Z* and that in the lock-in amplifier were zero and about 1 Kù [7]. External vibration was applied by sweeping up its frequency at the constant amplitude of acceleration of 1 m/s^2 [8].

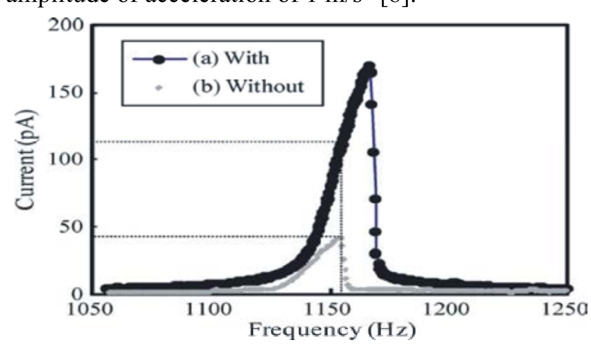


Fig. Amplitudes of output ac currents (a) with and (b) without the electret. Both are without bias voltage. The peak value with electret is 170 pA at 1166 Hz. The peak value without electret is 42 pA at 1154 Hz. Since the value with electret at 1154 Hz is 107 pA, the net increase with electret is 65 pA.

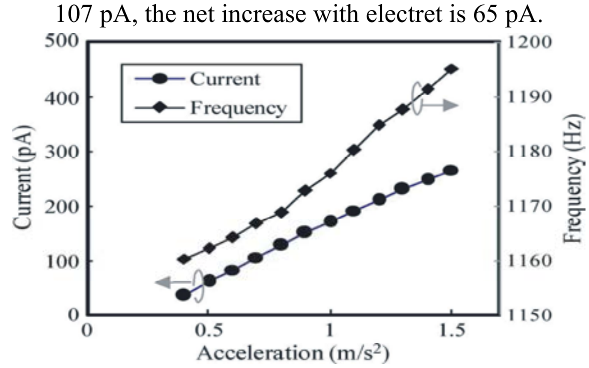


Fig. Current and frequency dependences on the amplitude of acceleration.

These results support that the movable part vibrated normally and generated the current under the electrical field by the electrets [9].

Codings:

A.ADC

```
#include<reg51.h>

sbit A1=P1^0;
sbit B1=P1^1;
sbit C1=P1^2;

void delay(unsigned char value2);
void adata(unsigned int);
unsigned char a,b,c,d;

void conv(unsigned int value1)
{
unsigned int huns,tens,ones;
 huns=(value1/100);
 txs(huns+0x30);
 tens=((value1/10)%10);
 txs(tens+0x30);
 ones=(value1%10);
 txs(ones+0x30);
 }

void adata(unsigned int adcout)
  {
  unsigned char val=0;
    val=val|(adcout&0x80)>>7;
    val=val|(adcout&0x40)>>5;
    val=val|(adcout&0x20)>>3;

    val=val|(adcout&0x10)>>1;
    val=val|(adcout&0x8)<<1;
    val=val|(adcout&0x4)<<3;
    val=val|(adcout&0x2)<<5;

    val=val|(adcout&0x1)<<7;
    conv(val);
    }
 void delay(unsigned char value2)
    {
    int i,j;
    for(i=0;i<=value2;i++)
    {
    for(j=0;j<=1000;j++)
    {
    }
    }
    }

void main()
{

while(1)
{
while(RI==0)
{
A1=0;B1=0;C1=0;
delay(50);

adata(adcout);
delay(100);

A1=1;B1=0;C1=0;
delay(50);

adata(adcout);
delay(100);

}
```

B.LCD:

```
#include <REGX51.H>
void lcdinit();
void lcdcmd(unsigned char value);
void lcddat(unsigned char *value);
void delay(unsigned int itime);
unsigned char *k="safety systems";
unsigned int i,j;
sbit rs=P3^5;
sbit rw=P3^6;
sbit en=P3^7;

void main()
{
while(1)
{
lcdinit();
lcdcmd(0x80);
lcddat(k);
}
}

void lcdinit()
{
```

```
lcdcmd(0x38);
delay(20);
lcdcmd(0x0e);
delay(20);
lcdcmd(0x01);
delay(20);
lcdcmd(0x06);
delay(20);
}
void lcdcmd(unsigned char value)
{
rs=0;
rw=0;
P0=value;
en=1;
delay(1);
en=0;
}
void lcddat(unsigned char *value)
{

for(;*value;)
{
P0=*value++;

rs=1;
rw=0;
en=1;
delay(1);
en=0;
}
}

void delay(unsigned int itime)
{
for(i=0;i<itime;i++)
for(j=0;j<1275;j++);
}
```

CONCLUSION

MEMS technology offers wide range application in fields like biomedical, aerodynamics, thermodynamics and telecommunication and so forth. MEMS technology can be used to fabricate both application specific devices and the associated micro packaging system that will allow for the integration of devices or circuits, made with non compatible technologies,with a SoC environment. The MEMS technology allows permanent, semi permanent and temporary connectivity. The integration of MEMS to present technology will give way to cutting edge technology that will give outstanding functionality and far reaching efficiency regarding space, accuracy precision, cost and will wide range applications. Describing typical application of MEMS in a hearing instrument application the flexibility and design challenges and various innovative features of MEMS technology is made to understand. In the hearing aid instrument microphone arrays are used to produce directional sensitivity and improve speech intelligibility. The various components and necessary signal conditioning algorithms are implemented in a custom micro packaging that can be implanted inside the ear canal is described.

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